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ABSTRACT

Projects at liberal arts colleges to help students understand technology, most of which were funded by the Alfred P. Sloan Foundations' New Liberal Arts Program, are described. Also included are John G. Truxal's essay, "Thoughts on Teaching Technology," which includes an illustration of technological problems/solutions posed by the pacemaker. The following college programs are described: Stanford University's Values, Technology, Science, and Society program; faculty development activities and course development and modification at Oberlin College; the inclusion of technology in elective and general education courses at Colgate University; strengthening the campus computing network using personal computers at Dartmouth College; Wellesley College's Technology Studies Program, which exposes humanities and social science majors to technology; teaching technology within a liberal arts context at Bucknell University; and faculty development activities as a catalyst for spreading technological literacy at Carleton College. Also described are programs at Connecticut College, Franklin and Marshall College, Grinnell College, Massachusetts Institute of Technology, Middlebury College, Rhodes College, Smith College, State University of New York at Stony Brook, Union College, and Wesleyan University. An annotated bibliography is also included. (SW)

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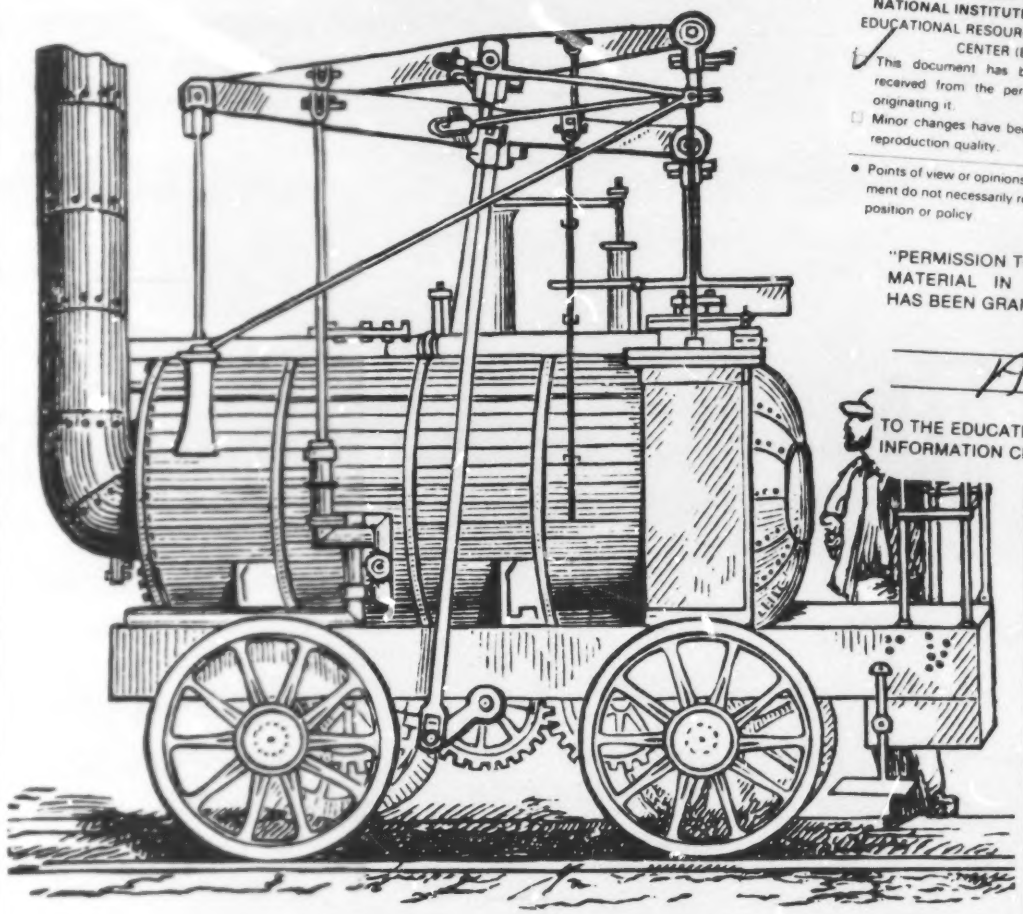

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Liberal Education and Technology

As emphasized by John Truxal in the following essay, an understanding of various technologies must include not only the relevant quantitative and scientific background but also the social, behavioral, economic, aesthetic, and ethical implications. Thus, the study of technology presents ideal opportunities for all students to consider themes and issues larger than their individual disciplines and to learn how to combine technical data with societal concerns in reaching decisions about real-world problems. Such skills, of course, transcend classroom exercises. To actively participate in the twentieth century as both leaders and citizens, students must have the skills and knowledge necessary to deal with ever increasing and changing technology.

For many liberal arts students and instructors the challenge is not merely to learn the historical development of a particular industry or explore the values issues raised by new inventions, but to confront the mathematical and technical skills required for a thorough grasp of the new technologies. The Alfred P. Sloan Foundation responded to this challenge in 1982 by creating the New Liberal Arts Program to fund projects at a group of liberal arts colleges interested in helping their graduates understand technology. The majority of activities described in this issue received grants under this program. Efforts range from the study of the computer both as a useful tool and as an example of technological advancement to quantitative exercises across the disciplines and consideration of technology's promises and threats. *P.A.B.*

Thoughts on Teaching Technology

by
John G. Truxal, Distinguished Teaching Professor
State University of New York at Stony Brook

Our entering college students may not score as well as their parents did on the standard verbal and math aptitude tests, but I believe they arrive with a much richer understanding of the world and the environment in which they will live and work. Today's students are at home with electronics and computers; they have some understanding of the energy crisis; they recognize the problems imposed by competition from Japanese manufacturers (although they have as little idea about what to do about it as our government leaders); and they are cognizant of the famine in Ethiopia and apartheid in South Africa.

Our task as college educators is to provide the system which converts these talented freshmen into alumni prepared for lifelong learning, for thoughtful adaptation to the environment they will confront as young adults, and for participation in public decision making on issues with technological content. In the terminology of engineering, we must provide a

system which *matches* the input (the entering students) to the challenges they will face after college.

All of the recent national studies of education emphasized the critical importance of scientific, quantitative, computer, and technological "literacies"--in addition to, not in place of, understanding in the humanities and the social sciences. There seems to be general agreement among educators that college students should have the opportunity to bring together knowledge, concepts, and viewpoints from various disciplines. Such transdisciplinary thinking is an essential part of learning about technology. To understand a technology, we must consider not only the relevant quantitative modeling and scientific basis, but also the social, behavioral, economic, aesthetic and ethical implications. The study of technology forces thinking across academic disciplines.

There are problems in trying to integrate technology into a liberal education. First, how do we teach technology in an institution of higher education? How is it to be done with existing faculty? What is to be taught? Is there enough easily-understood written material available to aid these teachers?

Certainly the question of "how" or "who" depends critically on the institution. Colleges and universities with programs in engineering or applied science have faculty with major career interests in technology. Many liberal arts colleges have to depend on faculty members for whom technology represents only a secondary aspect, subsidiary to their primary interests of music, art, ethics, history, political science, etc. For this group, substantive educational material in technology can enrich existing courses. The challenge we face as educators is to develop the new courses (or segments of courses) which will give students depth of understanding in an area of technology, confidence that they can indeed learn technology, and recognition of the pleasure available from that learning.

In this country our engineering schools emphasize two characteristics:

1. The engineer is given a problem; she or he has no choice and is not free to change the problem to one that is more easily solved. We must do the best we can with the given conditions.
2. The U.S. engineer tends to work from the specific to the general. We over-simplify the problem first, then gradually introduce the real-world complications. We seek a general theory only after solving a group of specific problems.

In the light of these two characteristics, I would like to use a specific example to illustrate how I conceive substantive technology being taught within a liberal arts program.

Pacemakers Illustrate Technology Studies Potential

The example is the cardiac or heart pacemaker—one of the truly remarkable technological achievements of the last 30 years. This electronic technology is now keeping 400,000 Americans alive—a major humanitarian contribution for a significant fraction of our population. Even if we resort to quantitative evaluation of this device and place a value of only $300,000 on each life saved (certainly a modest figure even for government system analysts), the pacemaker gives us a total benefit of 400,000 × 300,000 or $120 billion—enough to pay for military and space electronics research over 30 years. (And we haven't even included the 300 pet dogs who have had pacemaker implants.)

The history of the pacemaker starts in 1774 when a three-year-old girl was revived by electric shock after she had "died" from a fall. A 1929 medical report report told of the restoration of heartbeat by electrical shock, but at that time neither medical knowledge nor technology was ready to capitalize on this information. It was only in the late 1950s that a pacemaker appeared—a natural by-product of the develoment of pulse generators for radar during World War II. (Intensive wartime research led directly to most of modern electronics and computers.) The pacemaker delivers an electrical voltage pulse to the heart at regular intervals to keep the heart beating. To pace the heart, we need to apply an electrical pulse of about four volts 70 times a minute (90 times for dogs); each pulse requires about 100 microjoules of energy. These essential characteristics come from physiological or medical studies and represent the specifications given to the designer.*

The first pacemakers were external to the human body. A surgeon brought the wires through the patient's skin and into the heart (initially to the right ventricle, now in some cases to the right atrium). These external devices were not at all convenient: the patient had to avoid water and physcial damage to the electronics, and infections occurred frequently at the point the wires entered the body. Obviously, an implant pacemaker was needed.

The desire for implantation brought out several serious problems:

- The pacemaker should operate for at least two years (today ten is the goal) without electronic failure—a severe demand on reliability. Fortunately, major electronic companies, notably AT&T with its trans-Atlantic cable, had discovered how to select components and design for assured longevity (electronic components tend to fail early, so they are first used for several years to ensure reliability).
- The plastic seal around the electronic circuitry had to remain intact even in the continuing presence of body acids—a chemical engineering problem which was serious during the early years. One manufacturer received a two-page letter from a patient. The first page profusely thanked the company for saving the writer's life; the second page announced the patient was suing the company because the plastic case had cracked and another operation was necessary.
- The battery had to last for two years. (Two years with 70 beats/minute at 100 microjoules each corresponds to a one-watt bulb on for over two hours—close to the limit of the batteries available at that time.)

*Electronic circuits generating such a train or series of pulses can be easily built in the laboratory by students from a kit, or the students can observe the output of an actual pacemaker on an oscilloscope.

Over the following years, these engineering problems were solved, and the users (physicians and patients) upped their demands:

1. **The transvenous pacemaker, implanted without open-heart surgery.** The wires were inserted in a vein, then pushed under fluoroscopic examination until the ends of the leads were properly settled in the heart. Installation was now simple and fast, no longer requiring open-heart surgery.

2. **The demand pacemaker.** From the earliest days, patients wanted the freedom to step up heart rate when excited or exercising vigorously. One model used a radio transmitter sending a radio signal through the skin to the electronic package. The patient could order the pacing rate up, then later down to normal. The demand pacemaker is even better. It allows the heart to beat normally, and an artificial pulse appears only when 1/70 minute elapses without a normal, autonomic pulse.

"The challenge we face as educators is to develop the new courses... which will give students depth of understanding in an area of technology, confidence that they can indeed learn technology, and recognition of the pleasure available from that learning."

3. **Battery check through the telephone system.** The electronics gives an increasing pulse rate as the battery approaches the end of its life. With a telephone check system, the patient can dial an 800 number, use the phone to transmit the pulses to a central lab, and obtain a test of battery condition. The patient with a demand pacemaker holds a magnet over the skin covering the electronics to deactivate the demand feature and allow the circuit to generate repeated pulses.

4. **A radioactive isotope of plutonium as the energy source** rather than a conventional battery in order to obtain a pacemaker's expected life of at least ten years. (Some patients objected to carrying a nuclear energy source. What effect would this have on people who were near them much of the time?)

These new developments followed sequentially through the 1960s and 1970s as, with the success of the technology, user demands grew steadily—the better the technology, the more the consumer wanted. Like most new technology, however, there were problems: for example, at several times the manufacturer had to "recall" particular models to correct weaknesses uncovered only after extensive use. When a radioactive isotope is used as an energy source, the plutonium is rented to the patient and has to be returned when the patient dies.

This example can be the launching point for several significant discussions broadly applicable to modern technology:

- The pacemaker is a modest version of extraordinary, life-sustaining technology. While many patients are reasonably healthy, and often young, pacemakers are used with people for whom the quality of life is marginal. This raises the questions of when does life end, when should special support systems be removed, and what are the national impacts (e.g., economic).
- The question arises of how to ensure that new technology is available equitably to *all* segments of our population, including the economically and culturally disadvantaged, or the sizeable group with no contact with our health care system.
- An enormously more difficult ethical issue is our social responsibility to the Third World nations. With a life-saving technology readily available, do we have a responsibility to make this available in less-developed countries?

This example illustrates three important features of technology. First, technology is conceptually simple—it was designed by human beings. The system or device may, like a computer, consist of thousands of parts, but each is simple and the designer assembles them with simple algorithms or rules. The pacemaker does not even have this superficial complexity. Second, consideration of any specific technology (and it makes little difference what the teacher selects) inevitably brings in other disciplines. Technology serves human purposes, so evaluation has to involve both humanities and social/behavioral sciences. Finally, learning technology is fun, exciting, and challenging.

Stanford University
Integrating Values and Technology

Stanford University's Values, Technology, Science, and Society (VTSS) program, begun in 1971 by a group of humanists and scientists, is an effort to give the study of technology the attention it deserves. According to VTSS Associate Chairperson Robert McGinn, the faculty who devised the program realized the relevance of the field to future generations, and implemented VTSS despite the negative public sentiment such a study elicited at its founding. The influences that prompted the development of the program are ascribable to the climate of the late 1960s and early 1970s, says McGinn, who maintains that the program's founders were responding to the lack of traditional general education requirements and attacks against technology made in the context of the Vietnam era. Says McGinn: "VTSS was designed to provide an educational forum in which technology and its impact on society could be considered in a less hysterical manner and in a broader historical and cultural context."

Although implemented in 1971, the VTSS program did not achieve degree-granting status until spring 1985. Prior to this development, students wishing to major in Science, Technology, and Society had to obtain approval from the university's Individually Designed Major Committee, although the number of students choosing to do so numbered no more than one or two a year. McGinn admits that during the first few years of the program's existence, there was "no coherent structure to our course offerings, and so we felt that we could not even call VTSS a field because we did not know what a VTSS degree program should look like."

The first stage in the program's development was the implementation of a VTSS honors program, created to allow students majoring in conventional fields to combine the study of technology with their regular course work. Honors students take six VTSS courses and complete an honors thesis relating technology to their major interest. Since 1975, approximately five students a year have opted to complete this program.

VTSS Gains Coherent Structure

The second stage in the VTSS program's evolution came in 1982 when, says McGinn, "our ideas about what a major might look like began to crystallize." VTSS administrators developed a "tripartite" curriculum structure consisting of a core, a technical depth component, and a thematic concentration component. They presented this plan to the Individually Designed Major Committee, which then applied these requirements to all students wishing to major in VTSS. These components have remained intact, and will serve as the VTSS' formal degree requirements when the program's degree-granting status becomes effective in fall 1985. Students pursuing a Bachelor of Arts degree are required to take all three components, while students earning a Bachelor of Science degree omit the thematic concentration segment, taking additional technical courses instead. Not as technically advanced as a straight science or technology major, the VTSS program nevertheless enables students to combine technical familiarity with other disciplines. These studies prepare them, says McGinn, for professions in such fields as business and public policy, which are increasingly called upon to make technology-related decisions.

Composed of seven courses, the core is designed, says McGinn, to introduce students to the "broad context in which science and technology operate," enabling students to pursue their studies from a variety of disciplinary perspectives. The first overview course explores such topics as technology and the transformation of cultures, technology and the emergence of modern consciousness, and Third World modernization. As a result, says McGinn, students learn to view science and technology as part of the cultural and environmental system.

Five additional courses allow students to study science and technology from philosophical and ethical, economic, historical, behavioral and aesthetic, and social scientific perspectives. Thus, according to McGinn, it is "impossible for them to look at the field in isolation—as if science and technology were practiced in a vacuum." Finally, the core seminar, intended for seniors who are either majoring in or doing honors in VTSS, engages students in a more in-depth study of advanced topics. The two-hour seminar focuses on subjects ranging from human reproduction technologies to the function of emotional factors in the practice of engineering.

Eager to strengthen the core, VTSS administrators, with support from the Pew Memorial Trust, are soliciting course proposals from all faculty members. McGinn estimates that VTSS will fund approximately 12 to 15 new courses. Offerings proposed thus far include Science, Technology, and Religion; Technology and Third World Development; and The History of Medicine.

Complementing the theoretical core, the technical depth component gives students the technical practice needed for the field. "The idea," says McGinn, "is that, while we want students to be adept at thinking critically about the nature and role of technology in society, we also want them to have a moderate degree of familiarity with one field of science and technology." The technical depth component requires all VTSS majors to take either a four-course sequence (progressing to the intermediate level in such departmental disciplines as biology, physics, engineering, or computer science), or a year-long "technical literacy sequence" course, The Nature of Technology, Mathematics, and Science. This VTSS course, recently developed with funding from the Sloan Foundation's New Liberal Arts Program, is designed "to enhance a student's ability to think quantitatively and to understand the character and interrelationships of technology, mathematics, and science." Students study such concepts as probability, energy, and conservation laws, working on problems to strengthen their quantitative and analytical skills. Students choosing to take The Nature of Technology, Mathematics, and Science must also take one other technical course from a standard department, preferably one relating to or reinforcing the topics covered in the VTSS course.

Also part of the technical depth component, though less demanding than the technical literacy elements, is a computer literacy segment, which requires students to complete an introductory course and display proficiency in using the computer in some degree of scholarly work (this could include word processing a term paper). Because technical expertise is not a prerequisite to entering the VTSS program, says McGinn, the technical depth component is a way of simultaneously building students' technical knowledge and confidence, and weeding out those students who are not serious about applying themselves to the scientific/technical demands of the field.

The third component of the VTSS program, the thematic concentration, is made up of six departmental and/or VTSS courses organized around a specific science/technology-related theme or problem. McGinn maintains that this segment helps students bring their broad background knowledge (gained through the core) and their technical literacy (acquired through the technical depth component) to bear on such topics as energy, history, en-

vironment, aesthetics and technology, public policy, and the impact of technology on the arts and humanities. Students wishing to focus on the problem of nuclear war, for example, might opt to take VTSS courses such as The Atomic Bomb in History, or Arms Control and Disarmament.

Courses Relevant to All Students

With the reintroduction of university-wide distribution requirements in 1979 (falling under eight categories of western culture; literature and fine arts; philosophical, social, and religious thought; human development, behavior, and language; social processes and institutions; mathematical sciences; natural sciences; and technology and applied science), VTSS courses have attracted students from all disciplines interested in the social, ethical, and cultural aspects of science and technology. Among the VTSS courses which fulfill distribution requirements

"VTSS was designed to provide an educational forum in which technology and its impact on society could be considered in a less hysterical manner and in a broader historical and cultural context."

are: Western Culture and Technology, a three-part sequence taking students from "Sumeria to Silicon Valley;" Technology and Musical Expression, studying the relationship between changes in technology and musical styles; and Philosophical and Ethical Issues in Public Policy, focusing on such topics as biomedical ethics and international rights.

McGinn is pleased that many humanities students enroll in VTSS courses. Maintaining that the humanistic aspects are a major part of the VTSS program, he says: "We have had the word 'values' in our title since the outset of the program, and this was a deliberate policy decision—to send the message to students that the humanities are integral to the consideration of science and technology in society."

Curricular coherence is the key to the success of science, technology, and society programs, says McGinn. He advises administrators of these programs to avoid "delicatessen" offerings, and make sure each course is intellectually sound and essential for students' progression in the field. —*N.M.L.*

For more information, contact Robert McGinn, Associate Chairperson, Program in Values, Technology, Science, and Society, Building 370, Stanford University, Stanford, CA 94305. 415/497-3069.

Oberlin College

Comprehensive Technological Emphases Across the Curriculum

Faculty development activities and course creation and modification have been the primary foci of Oberlin College's participation in the Sloan Foundation's New Liberal Arts Program. Awarded a $250,000 grant in 1982, the college has made efforts to illustrate to faculty and students the relationship between technology and the humanities, with special emphasis on computer applications and introduction of quantitative methods, such as decision analysis.

The Sloan grant came at a propitious time, according to Norman Henderson, chairperson of the Committee on Technology and Applied Mathematics, who maintains that administrators were concerned about students' declining mathematical/technological sophistication. "We realized that students from liberal arts colleges were becoming further and further removed from an understanding of basic technology," he says. He believes that this is due in part to a relaxation of distribution requirements and also to the fact that technology is becoming so complex that students tend to avoid dealing with it. Involvement in the program, says Henderson, has allowed administrators to introduce mathematics and technology "in a gentle manner," thus at least raising faculty and student awareness about technology's impact on society.

Overseeing these activities is the Committee on Technology and Applied Mathematics, composed of faculty members from all college divisions. The committee reviews course proposals submitted for support from Sloan funds and encourages the development of short courses during the January interim term. (Used as a pilot period, the interim terms allows faculty members and administrators to determine whether a course is worth expanding into a lecture series or full-semester offering). The committee also provides small grants to faculty members seeking to develop courses that would introduce technology to students whose major fields do not necessarily cover technology.

Faculty Development Opportunities

The primary vehicle for faculty development has been the lecture series (open to the campus community), which in the 1983-84 academic year focused on technology and the fine arts. Lectures presented by both on- and off-campus experts ranged from computer animation to the architectural applications of computer graphics, and were supplemented by a ten-day seminar on The History of Technology in the Visual Arts. Examining the effects that computers and other technologies have had on the visual arts, the seminar leader presented pro-

grams designed to approximate the artist's decision-making process. Non-credit short courses open to both faculty and students continued the art and technology theme in January 1985, with computer art classes and a course/colloquium on working in marble, which illustrated the importance of such sciences as chemistry in dating various art works. The response to these offerings has been positive, says Henderson, who notes that the high degree of interest, ironically, poses some problems, budgetary constraints making desired computer aided design-computer aided manufacturing (CAD-CAM) and three dimensional facilities unavailable at present.

Shifting focus in the 1984-85 academic year from the visual to the musical arts, the lecture series included presentations on technology in musical composition and electronic music trends. Music Technology: Present and Future, a short course designed for individuals with little or no musical or technological knowledge, explored the social and artistic implications of the new technology in music, and gave participants the opportunity to develop original compositions on a computer music workstation. The 1985-86 lecture series will focus on artificial intelligence and robotics.

The first formal faculty development program was a 1984 short course in decision analysis. The course, taught by an instructor from the mathematics department, attracted approximately 25 faculty and administrators, who were encouraged to integrate the method into their own fields. According to Henderson, who has used the method in his introductory psychology courses, decision analysis "is a fairly simple way to describe how to make choices that optimize the outcomes for a particular situation. It is a formal method for making decisions giving some indication of the probabilities of different outcomes and the value or utility of those outcomes." Henderson notes that decision analysis techniques have been presented in conjunction with a discussion on genetic diseases and amniocentesis procedures in an introductory biology class, and have also been applied as a way of assessing values in a religion class on medical ethics.

The most recent program designed specifically for faculty members and administrators was a computer graphics workshop which demonstrated how this tool can be applied to all disciplines. A June 1985 course will provide faculty members with the basic computer research skills needed to develop confidence in using the computer as a tool for information exchange. Henderson maintains that Oberlin's approach to faculty development is low-keyed; professors are encouraged but not forced to participate in the various activities. "We believe that in a liberal arts college like Oberlin, mathematical and technlogical concepts will probably spread more widely if many instructors begin to introduce them in their courses," he says, "but we are not putting heavy pressure on our faculty to move in these directions." He feels that the desired effects of faculty development will gradually be realized in the classroom, as more and more professors are "sensitized" to the importance of technology.

Courses Incorporate Technology

In addition to offering lecture series and short courses, faculty members have developed and modified full-semester courses to include technical components. The instructors of Computer Applications in the Humanities provide students with computer programs to aid them in literary text analysis and teach them basic statistics useful to humanities research. A broadly designed course giving an overview of computer applications in many disciplines, Computer Applications in the Humanities explores topics ranging from synthetic music and graphic arts to stylistics and deductive logic. "The department which offers this course, classics, was originally thought of as being far removed from the computer and its applications," says Henderson, who notes that the course has sparked a great interest in computers among humanities faculty and students.

Courses in psychology and economics also emphasize computers. Laboratory in Personality and Social Psychology allows students to apply statistical analysis to behavioral data using Statistical Package for the Social Sciences software. Computer simulations have been integrated into six established economics courses; Price and the Market Mechanism, for example, gives students the opportunity to use MICROSIM-A, a computerized microeconomic simulation, to compete against each other through pricing and production strategies.

Students' declining mathematical/technological sophistication...is due in part to a relaxation of distribution requirements and also to the fact that technology is becoming so complex that students avoid dealing with it.

Henderson maintains that although focus on computer applications is important, it is not the only technological emphasis developed. Nuclear Power, for instance, explores societal and political ramifications, its syllabus touching upon such topics as antinuclear protest movements economic considerations, weapons, and waste disposals. A new course, Technology, Work, and Gender, examines the development of western technological perceptions, giving specific attention to the impact technological innovations have had on women's lives.

Faculty also strive to address students' mathematics and computer anxieties with such courses as Mathematics as the Language of the Physical Sciences, which exposes students with limited mathematical backgrounds to topics in Euclidean geometry and integral calculus in a

"non-threatening way," emphasizing mathematics' importance to scientific study.

Henderson is pleased about the wide range of courses available, and is certain that these will continue to expand. "We are open to almost any proposal that has some basis in technology or applied mathematics," he says. "We encourage the idea of developing such courses throughout the various academic departments."

—*N.M.L.*

For more information, contact Norman Henderson, Chairperson, Committee on Technology and Applied Mathematics, Oberlin College, Oberlin, OH 44074. 216/775-8361.

Colgate University

Infusing Technology Into Electives And General Education Requirements

Building on campus interests and enthusiasm, Colgate University is examining how attention to technology can have a long-term impact on the curriculum. Technology is a new emphasis in the recently revised general education program, and students and faculty are developing their quantitative and computer skills in a variety of courses and workshops. Many of these efforts are funded by the Sloan Foundation's New Liberal Arts Program, reports Charles E. McClennen, associate dean of the faculty and director of the Sloan grant.

Instructors are exploring different ways to include technology in the general education offerings. Beginning in fall 1985, they hope to provide an overview of the program, including its technical emphases, during freshman orientation. The orientation's tentative theme is "mapping the world," an exploration of map making from ancient techniques to computer mapping.

General education course work begins with Roots of Western Civilization, which extends from the *Odyssey* to the Pilgrim experience in America. During summer 1985, instructors will explore how to highlight such technical topics as Leonardo da Vinci's mechanical drawings and the building of a medieval cathedral. The program's second course, The Modern Experience in the West, examines nineteenth century Europe and the United States and already focuses on technology and its impact with discussions on new urban centers and the industrial revolution.

Students next choose one course from a variety of offerings devoted to specific nonwestern cultures. Area specialists will cover such technological issues as transportation, communications, and agriculture in the courses planned for this requirement. The final general education course examines both the technology associated with specific issues and the related ethical and social concerns. Options include Nuclear Weaponry, which will focus on nuclear technology and social values, and Cancer: Definition, Analysis, Treatment, which emphasizes biotechnology. With funding from the Kellogg Foundation, instructors are integrating the concerns and technology related to world food supply into the latter half of the general education program.

The university also has introduced a lecture series that supplements the general education offerings and includes some technology themes. A number of lectures each term are required of students in the various courses. For example, spring 1985 lectures which complement Modern Experience focus on Civil War-era technology and cover such topics as photography, medical equipment, and firearms.

Electives Explore Computers and Problem Solving

Students can also study technology and quantitative reasoning in departmental electives. During the one-month January term faculty members offer several courses on problem solving. Their purpose, according to McClennen, is to address student deficiencies in analysis and interpretation. "Students can memorize anything," he says, "but we want them to be able to look at unfamiliar data, know what it means, and use it constructively." In a course on voting and elections, for example, students analyze federal election results.

Instructors often use January term courses to test topics they would like to develop into full term courses. Introduction to Quantitative Research in the Social Sciences began as a January offering and is now a sophomore course that is highly recommended for social science majors. It provides hands-on experience in analyzing real-world data sets and is taught by two faculty members drawn from the departments of education, geography, political science, and sociology-anthropology on a rotating basis.

Another popular elective is Computers in the Arts and Sciences. Faculty members representing the various liberal arts and science disciplines developed the freshman course and teach individual sections. The instructors act as guest lecturers in each other's classes, presenting units on their areas of expertise. Students learn how computers function and gain an understanding of their applications in different disciplines. Topics range from financial modeling and statistics to music synthesis and text processing.

Faculty Development Responds to Various Needs

To help faculty consider the possibilities for infusing technology into all aspects of the curriculum, the committee responsible for distributing the Sloan funds has been very open-minded about what is meant by technology, emphasizes McClennen. "We want to provide a spectrum of options," he says. In addition to course development funding, activities have included workshops taught by a mathematician turned computer scientist on microcomputers and mathematical models in social sciences. To ensure uniformity in equipment and encourage computer usage, the university offers stipends of up to

$750 to faculty members who purchase the type of personal computer used on campus.

Other efforts include a computer course conducted by a chemist for faculty members in his department. Believing that existing courses could be upgraded by using computers in laboratory exercises and homework problems, he taught his colleagues how to design these assignments. Each participant took one course off during the term, and the Sloan committee funded a temporary instructor to fill the vacancies. McClennen speculates that this model could apply in other departments, although he notes that the instructor would need to have the training and self-confidence to teach colleagues who may have more seniority.

"Students can memorize anything, but we want them to be able to look at unfamiliar data, know what it means, and use it constructively."

The computer science department is developing the Scholar's Workbench, a project which will enable faculty to access the operations available through Colgate's mainframe computer through their microcomputers. The project will provide access to bibliographic searches, statistics and graphics packages, and word and text processing. Admittedly an ambitious project, says McClennen, the designers need time for designing and conducting the creative programming needed to put it in operation.

McClennen is pleased with Colgate's progress in introducing technology to both faculty and students. A guiding principle in the various activities, as noted in a project proposal, is that "not all faculty development assistance should be linked to activities showing... immediate application in the classroom... to make best use of one of its resources, (Colgate) must invest in the long-term growth of its faculty." —*P.A.B.*

For more information, contact Charles E. McClennen, Associate Dean of the Faculty, or Margaret Maurer, Director of University Studies, Colgate University, Hamilton, NY 13346. 315/824-1000.

Dartmouth College

Personal Computers Strengthen Campus Computing Network

During the last 20 years, Dartmouth College has developed what Dean of the Faculty C. Dwight Lahr calls a "rich computing environment." He contributes much of this atmosphere to former President John Kemeny's vision of the potential of computers in undergraduate teaching and development of the Basic computer language. Although students are not required to take computer courses, the campus philosophy is to make computing so "seductive" that they cannot avoid it, says Lahr; a 1981 survey revealed that 97 percent of the students had used computers by the time they graduated.

"We want our graduates to think of the computer as just another tool, much like pencil and paper," says Lahr. Faculty members representing departments ranging from English and sociology to physics and music have developed computer exercises that use the college's time-sharing system. Sessions conducted by Dartmouth instructors at a 1983 Sloan Foundation workshop coordinated by the Massachusetts Institute of Technology illustrate the variety of applications in place at the college. Instructors demonstrated how the computer can be used to teach grammar and punctuation, access the library catalog, and coordinate an audio-visual presentation.

In fall 1983 Dartmouth administrators received Sloan Foundation funds to convert a number of existing computer-based instructional activities from a time-sharing to a personal computer mode. Faculty have been working on a form of Basic for personal computers that conforms to new guidelines established by the American National Standards Institute. The idea behind the ANSI standards, says Lahr, "was that if a standardized version of Basic could be developed, then, regardless of which microcomputer was used, you could run any Basic program on that machine." Dartmouth instructors have developed True Basic, a form of Dartmouth Structured Basic that can run on both IBM personal computers and the Apple Macintosh.

Personal Computers Offer New Approaches

Originally intending simply to move the time-sharing programs to the personal computer, instructors soon discovered that the new technology "represented a revolutionary breakthrough in hardware," says Lahr. "The microcomputers gave us the ability to take original ideas that were good and implement them in a much better way." While the time-sharing system utilizes a typewriter terminal, the personal computers feature graphics terminals that use both text and illustrations.

"Once faculty saw the advantages of a graphically-based microcomputer, they came forward with newly conceived projects," says Lahr. While the projects' pedagogical goals often remained the same as those of the earlier time-sharing exercises, the applications varied as faculty discovered new ways to introduce subjects and concepts. For example, an English program on the time-sharing system drilled students on subject-verb agreement. The Macintosh program includes not only the drills, but also, on a separate part of the screen, examples of correct grammar usage and a dictionary which students can use to look up words. A similar program is also used to teach foreign languages and test vocabulary through association of words with pictures.

Personal computer programs in development at Dartmouth include an atlas of world history and a database for art history students. In the former, the computer will project overlays showing geographical features and historical phenomena on outline maps. The art history database will provide information on narrative scenes in Early Italian Renaissance Art.

A catalog of applications already in place includes a sociology statistics laboratory, music composition exercises, and practice solving Venn diagrams. Sociology students conduct such analyses as cross tabulations or absolute or relative frequency tabulations on datasets on social norms, group influence, and marriage roles drawn from sociological surveys. The Venn program is used in introductory philosophy courses to teach syllogisms. Students learn about musical composition in Appletones, a program that allows them to create a musical work by arranging 12 pre-defined sounds, using variations in duration, timbre, and volume. In another music program students compose minuets by arranging six pre-defined, two-measure phrases written by Mozart. The educational software used in these applications is available for the cost of distribution only, to colleagues at other colleges and universities.

"The microcomputers gave us the ability to take original ideas that were good and implement them in a much better way."

Courseware Development Requires Team Effort

To enable humanitists and social scientists to take full advantage of the personal computer's capabilities, administrators matched faculty members with ideas with student and academic computing center programmers. "Our approach is that if we are going to meaningfully integrate computing into our courses, we have to assume that faculty will not do the programming," says Lahr. The combination of "someone who knows the field inside and out" and "someone who can turn the ideas into a set of instructions to the machine" is important in developing successful programs. Faculty members provide the intellectual guidance and act as potential users for the programming teams that do the actual coding.

Humanities and social science faculty members are currently ahead of science instructors in developing personal computer applications, reports Lahr. A grant from the Keck Foundation will address this discrepancy and fund courseware development in the sciences.

Before the individual projects were funded, academic computing specialists and computer-knowledgeable faculty members conducted workshops on the personal computer's capabilities and introduced standard computing applications, such as text processing and the use of spread sheets. Lahr has learned that faculty members are more impressed by how their colleagues use the equipment than by people "who look like they were probably born with a computer in their cradle." As part of its commitment to computing, the college has made Macintosh computers available to faculty members interested in using them in their courses; about 50 percent of the faculty use computers owned by the college.

Student reaction to the increased use of personal computers can best be described as "Macintosh-mania," says Lahr. Beginning in fall 1984 administrators encouraged freshmen to purchase the microcomputers they would be using in their courses. Approximately 80 percent of the freshmen purchased Macintoshes, which are sold at a reduced rate and included in financial aid packages. The college recently extended the local computer network to all dormitory rooms and campus offices, thus providing such services as word processing, library catalog access, and electronic mail.

The integration of computing across the curriculum can begin with a few committed faculty members, according to Lahr, who notes, "A few converts can influence the rest." He cautions against using the computer in situations where, for example, an overhead projector is just as effective. "The major thing to remember," says Lahr, "is that using computers should be fun for students and faculty. In cases where that is not true, a computer is not appropriate." —*P.A.B.*

For more information, contact C. Dwight Lahr, Dean of the Faculty, Dartmouth College, Hanover, NH 03755. 603/646-3999.

Wellesley College
Understanding Technology And Its Implications

Implemented in fall 1983, Wellesley College's Technology Studies Program offers humanities and social science majors "opportunities to develop the skills necessary to understand and evaluate technological innovations," according to Program Director Owen J. Flanagan. Developed with Sloan Foundation funding, the program includes public lectures, faculty development activities, and interdisciplinary offerings on technology. Students who complete five technology studies courses earn a minor from the program.

A fairly broad definition of technology is used to identify topics which are appropriate for the new program, reports Flanagan. As detailed in a program brochure, "technology may be distinguished from traditional liberal arts disciplines by its focus upon practice." While science is concerned with efforts to "understand the nature and function of natural phenomena, technology develops and uses this understanding to achieve material goals." This definition, says Flanagan, emphasizes the

program's focus on "the way artifacts or sets of artifacts either work or change the world."

Students can acquire this basic understanding of technology through Technology Studies 100, the program's introductory course, which can be applied toward the college's science and mathematics distribution requirements. Offered for the first time during the 1983-84 academic year, this two-semester course is taught by a faculty team consisting of an economist, a mathematician, a physicist, and a sociologist. The course develops students' mathematical and analytic skills through the study of logic and circuits, amniocentesis, family and household structure, and heating and cooling. Lectures and hands-on exercises emphasize measurement, modeling, and probabilistic reasoning, as well as the development of students' ability to critically consider value-related issues.

For example, the section on amniocentesis introduces measurement and probability tools before examining the specifics of ultrasound technology. Students learn how physicians use probability to determine whether the test is appropriate for patients in particular age groups. They also explore the social ramifications of amniocentesis, including its use by couples interested in learning their child's sex. In another section, the class studies symbolic logic and basic electronics by building electronic circuits.

At the end of the year-long course students participate in a group project. In spring 1984, for example, the class investigated the most cost-effective and environmentally-sound ways to heat and cool the campus library. Looking first at the current system, students next researched and analyzed alternative heating and cooling methods, including the use of a lake located next to the library. They consulted engineers, collected field measurements, and considered how utilizing the lake might change its ecology.

After completing Technology Studies 100 students appreciate that technology, even in its simplist form, can transform the world very rapidly, says Flanagan. They understand how various technologies work and have a sense of their problems and prospects. Originally conceived as a prerequisite for other program courses, Technology Studies 100 is no longer required since instructors determined that courses would be taught as individual units rather than as part of a learning sequence, says Flanagan, who emphasizes that the course is still strongly recommended.

Courses Examine Various Technologies

Other technology studies courses reinforce the program themes in their examination of a variety of technologies. A popular offering is Television Technology and Social Impact, which combines an analysis of television programming with an understanding of broadcast technology. Using video recording and editing equipment, students prepare political messages and measure audience reaction to their projects.

In Structure in Music: Experiments in Computer Modeling, the undergraduates study "the relationship between standard musical notation and the language of LOGO computer procedures" and compose simple music pieces using a computer. Flanagan is pleased that the technology studies courses have each attracted between 12 and 15 students, an enrollment which compares favorably to other Wellesley courses. Future offerings will look at technology's impact on third world cultures and analyze energy policies and alternatives.

In addition to these new courses, several existing courses are cross-listed with the Technology Studies Program. These include Medical Ethics, which examines the social and ethical implications of such issues as genetic engineering, euthanasia, and organ transplants, and Science, Technology, and Society, an exploration of the connection between scientific discoveries and everyday life. Because Wellesley and the Massachusetts Institute of Technology have a course exchange agreement, interested students may also pursue further course work in technology with offerings from MIT's engineering departments and Science, Technology, and Society Program.

While science is concerned with efforts to 'understand the nature and function of natural phenomena, technology develops and uses this understanding to achieve material goals.'

Computer-Literate Faculty Study Technology

Flanagan notes that only a few technology studies courses emphasize computers. Because attention to developing faculty members' computer skills began in the mid-1970s at Wellesley, computer literacy is now taken for granted. "We think of computers as just another example of a technology which is immensely useful and which has to be thought about and understood," says Flanagan. At the same time, administrators recognize that faculty members need additional acquaintance with technology. Instructors have attended workshops conducted by outside experts on various technological concerns. A faculty committee reviews proposals for technology studies courses and funds the development of new offerings.

To increase faculty acceptance of technology's importance, the Technology Studies Program also supports research that will not necessarily result in new courses. Flanagan calls the Sloan Faculty Research and Scholarship Awards an effective way to provide opportunities for faculty to think in new ways and begin to change the college culture. For example, a comparative literature specialist in the German department is examining how science has been presented in literature since Bacon. The

program also coordinates public lectures that introduce the program's interests to the campus.

In the future, Flanagan would like to involve more mathematicians and scientists in the program, an effort he admits is difficult because these instructors are less interested in applied topics and cannot be spared from their department assignments. He is pleased that in two academic years the program has already increased student and faculty awareness of the pervasive nature of technology. —*P.A.B.*

For more information, contact Owen J. Flanagan, Jr., Director, Technology Studies Program, Wellesley College, Wellesley, MA 02181. 617/235-0320.

ADDITIONAL PROGRAMS

Bucknell University

Teaching Technology Within A Liberal Arts Context

Intent upon closing the gap between technology and the humanities, Bucknell University faculty members and administrators have embarked upon a course of action to encourage exchange between the disciplines. Although a small, liberal arts college, Bucknell's offerings are also geared toward professional studies, with programs available in such fields as engineering, management, and pre-medicine. This particular academic mix, notes Vice President for Academic Affairs Frances D. Fergusson, creates an environment conducive to collaboration. With the aid of Sloan Foundation funding, Bucknell introduced a variety of programs to strengthen technological literacy within the liberal arts framework.

Reaching out to faculty who had scant technological knowledge, engineering and natural science faculty members conducted workshops on technological literacy in the liberal arts during summer 1983 and January 1984. These seminars were designed to help humanities faculty overcome computer anxiety, understand the relevance of computer applications in their disciplines, and learn about mathematical modeling. According to a progress report, the seminars "were a great success both intellectually and socially: faculty talked together about subjects of mutual interest and a new respect was forged."

Sharing their insights led faculty members to conclude that a committee was needed to oversee Bucknell's technological development. As a result, instructors and administrators have created a university-wide committee to examine the effects of technology in the coming decade on the total curricula.

In conjunction with the workshops, faculty members undertook individual projects, many of which have become ongoing activities contributing to the university's technological progress. Fergusson notes, for example, that textual analysis software developed by a workshop attendee has now been fully implemented into Bucknell's writing program.

Additional faculty development included a two-year lecture series begun in 1983 on Technology and the Future Challenge of the Professions. Outside lecturers spoke to faculty on issues ranging from copyright laws to medical ethics, focusing on technological changes in different fields.

The efforts to integrate technology into the humanities have also affected course development, says Fergusson, noting the appearance of two new offerings: the History of Technology, which extends from ancient times into the nineteenth century, and Women, Science, and Technology, which examines the impact that science and technology have had on women, and vice versa.

Intensified Future Collaboration Planned

With additional Sloan Foundation funding, administrators propose to increase discipline integration to further enhance the curriculum's technical component. Under the supervision of a visiting professor experienced in teaching technology in a liberal arts context, the university will create a mentor system, bringing together humanities faculty with colleagues from engineering and the sciences. Bucknell President Gary A. Sojka, himself a scientist and liberal arts proponent, emphasizes that the new mentor program will be a two-way exchange. "The thought," he says, "of a society filled with individuals with technical knowledge but without some formal training in the ways to deal with the almost inevitable ethical and moral dilemmas that result from technological advancement, just chills my blood." By the same token, he is also concerned about "a preoccupation with the humanities, which seems to exclude consideration of the fact that we live in a scientific, technological society. That," he says, "is part of the human condition, and it is the role of the humanist to deal with that material."

Administrators are encouraging faculty to incorporate or increase the study of technology in their Freshmen Adviser Seminars, established courses limited to 15 students which address specific topics such as Nutritional Ecology and Science, War, and Peace. Students taking these seminars become the advisees of the instructor for the next two years, allowing a close relationship to develop. This is an ideal situation, notes Fergusson, in which to stress the relevance of technology to students' lives.

To maintain interest and involvement in technological literacy, administrators forsee the development of an ongoing seminar in the New Liberal Arts. Such a vehicle would promote continued dialogue among the disciplines and, administrators believe, "keep a concern with the new liberal arts at the forefront of Bucknell's awareness as an institution."

Fergusson asserts that Bucknell's participation in the Sloan New Liberal Arts Program has been overwhelmingly positive. "We no longer have people who are big skeptics about technology," she says. "Instead, we have a very enthusiastic group of faculty and a very strong technical environment." —*N.M.L.*

For more information, contact Frances D. Fergusson, Vice President for Academic Affairs, Bucknell University, Lewisburg, PA 17837. 717/524-1561.

Connecticut College

Introducing Quantitative Studies In Disciplinary Courses

To help students learn "to think in quantitative terms," Connecticut College faculty members have developed

three disciplinary courses in quantitative reasoning. With funding from the Sloan Foundation New Liberal Arts Program, the instructors designed introductory courses that focused on the application of mathematical and statistical techniques in history, psychology, and sociology. The new offerings satisfy the college's quantitative disciplines and logic course requirement.

Because "we work in a world of numbers," the instructors recognized the need for students to become familiar and comfortable with quantitative issues, according to Associate Professor Robert Hampton, who teaches Quantitative Reasoning in Sociology. The instructors also wanted their students to be able to interpret statistics in different contexts and understand how statisticians arrive at their results. Hampton stresses that the courses focus on the "conceptual rather than the computational bases for statistical reasoning."

Offered for the first time in spring 1984, the pilot courses were designed for freshmen and assumed no mathematical competency beyond high school level. The instructors directed the materials at the more general student rather than the potential major in their fields so that students would learn procedures that could be used in courses throughout their undergraduate programs.

During summer 1983, the three instructors, chosen by the dean of the faculty for their interest and expertise in quantitative issues, developed the courses with the assistance of a mathematics professor. Rather than following the outline of a traditional statistics textbook, they prepared courses that built on their own disciplinary training and background, reports Hampton. The common themes, he says, were "how do you measure phenomena and how do you interpret the data that you received."

The courses combined lecture and discussion, in addition to computer laboratories that provided hands-on opportunities for students to conduct disciplinary-related simulations. The mathematics professor assisted with the laboratory sections and helped the instructors understand their fields' quantitative materials from the standpoint of a mathematician, according to Hampton. She also suggested approaches to teaching formulas and equations that were unfamiliar to the other instructors who had less experience teaching statistics.

Courses Draw on Disciplinary-Related Topics

Quantitative Reasoning in Sociology began with an introduction to empirical research in sociology. Students studied the various data presentation and manipulation options available to sociologists and learned how these are used in different situations. Using such data as the Consumer Price Index and the United States census, they conducted description and analysis projects. In a demographics exercise, for example, they worked with a computer package that detailed population data on 146 countries and used the age composition program to answer questions about a particular country's current and projected population and the implications of fertility or life expectancy changes.

Intelligence testing provided the theme for A Quantitative Approach to Psychology. Students studied both the statistical rationale for intelligence testing and the objections that have been raised by these measurements. Computer simulations focused on IQ inheritance and development and college admissions decisions. Quantitative Reasoning for Historians examined family structures from the seventeenth to the twentieth century in its study of the application of quantitative data. In addition, students learned about the uses and abuses of statistics by historians.

A total of 22 students enrolled in the three courses during the pilot semester. Most rated the courses highly, and word-of-mouth has attracted 24 students alone to the spring 1985 offering of the sociology course. The history and sociology courses will continue to be offered, although the history course may be directed at more advanced students in the future; according to a report by the history instructor, some beginning students lacked the commitment and sophistication necessary to appreciate the relevance of quantitative approaches to history. Because of low demand for the psychology course, the instructor has integrated the quantitative materials into a new course on Research Methods in Psychology.

After the sociology course has been offered for several years, Hampton would like to evaluate its impact on students. He emphasizes that a course in quantitative reasoning is appropriate for all students. "Students need to be as articulate in quantitative areas as in others," he says. "It's a great skill to have whether you are a journalist trying to make sense of a tax simplification plan or a member of a community considering closing an elementary school based on the projected population."

—*P.A.B.*

For more information, contact R. Francis Johnson, Dean of the Faculty, Connecticut College, New London, CT 06320. 203/447-7569.

Carleton College

Technical Progress Through Faculty Initiative

Counting on faculty development activities to act as a catalyst for spreading technological literacy across campus, Carleton College administrators have not been disappointed. Since the college's participation in the Sloan Foundation's New Liberal Arts Program in 1982, faculty members have introduced new courses focusing on technology and computers, integrated technological components into existing courses, and undertaken research projects to develop new teaching strategies and offerings. Says Dean of the College R.O. Elveton: "There will be significant curricular consequences as a result of faculty interest in technology."

Faculty development efforts began with workshops designed to reach social science and humanities instructors who required introduction to computing basics. Held during the 1983 summer and winter breaks, these three workshops were sequential, focusing first on elementary programming, next offering instruction in Pascal, and finally presenting the LOGO language and concepts of artificial intelligence. Faculty response to the workshops was positive, with approximately 40 percent enrollment, says Elveton. He notes that the workshops deliberately avoided word processing as a topic, Carleton's technology program being "primarily concerned with increased faculty comprehension of the microcomputer as a research and teaching tool."

Workshops continued on a departmental basis, departments choosing which topics to explore for a two-week period. History instructors, for instance, focused on computer-assisted statistical analysis, while members of the economics department concentrated on computer graphics, developing a computer simulation of a macro-economy.

Continuing under the auspices of the academic departments, additional workshops examined the uses and limitations of quantitative and computer applications in the humanities and social sciences. In conjunction with these workshops, faculty members received research grants to develop courses and ma-

terials. As a result, professors have studied such topics as databases, computer graphics, and statistical software. Faculty members have created new courses; among them Artificial Intelligence, which explores the attempt to program computers to simulate intelligent behavior, and Technology and the Novel, focusing on literature that describes modern man's encounters with technology.

Faculty seminars, to be offered during the 1985 summer and winter breaks, constitute the third stage of faculty development efforts. The History of Technology seminar will survey the characteristics of rapid technological growth; The Nature of Technology will try to determine whether technology is "an extension of essential human capacities or an aberration of human activity;" and Society and Technology will focus on technology's impact on societal organization.

Technological Sophistication: A Gradual Process

Elveton maintains that while many faculty members have been consciously working to strengthen the technical aspects of their courses, technology has not pervaded the entire curriculum. "We do not want technology to devour the curriculum," he says, acknowledging that a majority of instructors have not included quantitative components in their courses. He stresses, however, that the nature of instruction, rather than the amount of quantitative analysis, has changed in many courses. "There has been increased pressure for students in all disciplines to have a more sophisticated understanding of technological applications," he says, noting that this has been an "incremental" rather than a "revolutionary" process. He asserts that close to 90 percent of all students will have encountered a computer in at least one course during their four years. "The most important thing about that statistic," he says, "is not just that students have used the computer, but that their use is becoming more significant and less tangential to their course work." Elveton notes, for example, that students in philosophy use the computer to learn logic.

"We want to avoid the superficial and offer courses that are intellectually challenging and meaningful to today's students," says Elveton. This idea is demonstrated in faculty efforts to further emphasize technology in several science-oriented, interdisciplinary concentrations (Science, Technology, and Public Policy; Environmental Studies; Computer Science). In addition, faculty are planning new courses to study technology in depth, such as an offering in "expert systems" (programming computers to simulate the analyses of human experts in fields such as medicine and geology). —*N.M.L.*

For more more information, contact R. O. Elveton, Dean of the College, Carleton College, Northfield, MN 55057. 507/663-4393.

Franklin and Marshall College
Keeping Pace with Technology

Stimulated by an invitation from the Sloan Foundation to participate in its New Liberal Arts Program, Franklin and Marshall College faculty and administrators began to plan for major changes in the organization of academic computing, believing a new structure was needed to accommodate impending curricular innovations inspired by the program. Thus, prior to its acceptance of a $25,000 Sloan grant in 1982, the college had established a Committee on Academic Computing and a Center for Academic Computing to facilitate faculty involvement with the new technology. "We felt that we needed to devise a new structure that would provide better support for an increasing constituency of academic computer users," says Director of Academic Computing Robert J. Friedrich, an assistant professor of government with experience in quantitative analysis. The Committee on Academic Computing, comprised of four faculty members, two students, and the director of academic computing, has primary responsibility for establishing policies for the college's academic computing operations.

Friedrich notes that under the committee's supervision, Franklin and Marshall's computing structure underwent a total transformation. Before the committee's inception, only one instructor was available part-time to aid academic computer users, and faculty and administrative staff both used the same computer system, often overloading its capabilities. Today, faculty and administrators each have their own systems, and the Center for Academic Computing is in the process of gaining an educational software development expert, a coordinator of user services, and a technical support specialist.

To encourage faculty to become knowledgeable about computer usage, the computing committee recommended that the college help instructors purchase their own machines. As a result, faculty members can now purchase the computer of their choice, with the aid of both a $1,000 gift from the college and a $1,000 interest-free loan. Friedrich notes that this venture proved successful, with currently 90 out of 135 faculty owning their own computers.

With regard to students, the committee proposed that 1985 incoming freshmen be encouraged to acquire their own Macintosh microcomputers. These machines will also be available in the Center for Academic Computing, and a new college initiative to provide faculty members with Macintoshes for their offices is underway. "The idea is that faculty and freshmen starting this fall will all have compatible computers, and this should facilitate the integration of computing into our curriculum," says Friedrich.

Sloan Funds for Faculty Development

Using its own resources to make the structural changes conducive to the support of a technological environment, Franklin and Marshall divided its Sloan grant for use in two faculty development projects: faculty and course development grants relating to computing, quantitative analysis, and technology; and a summer faculty seminar on statistics and computing.

According to Friedrich, instructors have applied for faculty and course development grants primarily to attend off-campus Sloan-sponsored conferences relating to computing and technology, and to purchase software for their own and students' use. These grants and the uses to which they have been put, Friedrich maintains, "have had a real impact on faculty's interest." He cites as an example a classicist using and encouraging students to use computers and quantitative methods for textual analysis, and a biology class acquiring software to allow students to analyze their diets. Although no new courses specifically emphasizing technology or quantitative methods have been developed thus far, Friedrich stresses that the Sloan money has been used primarily to strengthen the technological aspects of existing offerings. He notes that courses in such departments as government, sociology, economics, and psychology (not to mention the natural sciences and mathematics), have long-established quantitative and computer components.

Designed for faculty from all disciplines teaching or preparing to teach statistics or statistics-related courses, the two-week long, faculty seminar held in July 1984 allowed professors to share insights on how statistical skills could best be incorpo-

rated into the curriculum. These discussions have led to the preparation of a new course in quantitative inquiry, which, says Friedrich, "will focus on the use of quantitative evidence to solve a broad range of problems."

Franklin and Marshall has recently received additional funding from Sloan to continue its progress in improving technological resources on campus. Among the future innovations planned are the creation of more formal computer sciences courses (only two are offered at this time); a course in science and technology; a faculty workshop on integrating quantitative analysis and computing into introductory humanities courses; and a summer faculty seminar in mathematical modeling. Faculty and course development grants will also be continued.

Friedrich asserts that the college's participation in the New Liberal Arts Program has been important in helping students and faculty perceive computers and quantitative methods as tools beneficial to every discipline. He affirms the college goals presented to the Sloan Foundation which state that "the major thrust of this program is not toward computer science per se, but toward the appropriate use of computing as an integral part of liberal studies." —*N.M.L.*

For more information, contact Robert J. Friedrich, Director of Academic Computing, Franklin and Marshall College, P.O. Box 3003, Lancaster, PA 17604. 717/291-4072.

Grinnell College

Teaching Technology Throughout the Curriculum

Grinnell College's Problem Solving and Technology Studies program is an effort "to infuse the study of technology throughout the whole curriculum," says Program Director Elliott L. Uhlenhopp. Implemented in summer 1983 with a grant from the Sloan Foundation, the program is divided into three levels which correspond roughly to freshman introductory courses, sophomore- and junior-level courses, and senior seminars.

Students do not systematically advance from level to level in the program, which is neither a degree nor a certificate option. Rather, students encounter these electives throughout the college curriculum. About 800 of Grinnell's 1,200 undergraduates registered for Level I courses during the 1983-84 academic year, with approximately 500 enrolling in Level II courses. Uhlenhopp cautions, however, that these figures are misleadingly high because some students take several courses in each level, resulting in some enrollment overlap.

Level I courses are offered primarily through the departments of chemistry, mathematics, psychology, physics and economics, and are modifications of existing Grinnell offerings designed to strengthen the quantitative problem solving ability of students. The definition of "problem solving" varies from discipline to discipline, according to Uhlenhopp. "In the chemistry courses," he says, "students have a specific set of word problems that involve a lot of mathematical manipulation and reasoning—taking a complex question and dissecting it into its component parts, and figuring out how to solve it. But to a mathematician or an economist, problem solving means something completely different."

Level II courses, also offered by a variety of departments, emphasize mathematical modeling. For instance, a theatre course on stage design uses computer graphics to simulate scenery, lighting, and construction options. Cultural ecology orientations amenable to quantitative treatment and modeling receive special emphasis in an anthropology course which includes a summary of the major theoretical orientations of twentieth century anthropology and archeology and the research designs used to test them. Many of these courses require prerequisites within their departments, although these may not necessarily be Level I courses.

Level III Includes Seminars and Internships

Level III of Problem Solving and Technology Studies has two parts: on-campus seminars and off-campus internships. The seminars, with about 15 students each, focus on an aspect of technology *per se*, rather than "integrating technology into some other subject matter," according to Uhlenhopp. For example, the 1984 seminar on Studies in Physical Technology examined the engineering of bridges and other large structures. The goal of these courses, which were developed as a result of the Sloan grant, is to provide an in-depth study of the scientific bases and limitations of particular technologies and their societal effects. Administrators have intentionally made the prerequisites for Level III seminars minimal to attract students from a broad range of liberal arts disciplines. "You certainly have to have had some type of quantitative literacy and familiarity with quantitative analysis problems," Uhlenhopp says. "But you are not required to take three years of chemistry before you can begin talking about energy technology."

Level III's other component is the Grinnell Technology Semester in Washington, D.C., an internship program run in cooperation with the Washington Center for Learning Alternatives. One faculty member, on leave for the semester, accompanies between six and twelve students to Washington each fall. The program, now approaching its third season, includes seminars and a technological internship in the metropolitan Washington area. As part of the fall 1984 Washington Semester's focus on Technology of Health Care Delivery, several students had positions at the National Institute of Mental Health. Uhlenhopp says that despite Washington's traditional role as a mecca for politically-oriented internships, the Grinnell Technology Semester has focused more on the biological and physical sciences. Students have a similar opportunity to complete summer internships at various technological centers across the country.

Uhlenhopp calls faculty development one of the program's most successful aspects. Instructors attend summer workshops and seminars both on and off campus on such subjects as computer programming, engineering, and statistics. They also spend time restructuring existing courses and developing new ones. To ensure the program's success, faculty members "have to truly believe in the philosophy of integrating technology into the liberal arts curriculum," says Uhlenhopp. "Fortunately, there is a receptive audience for that point of view at this institution."

The program's biggest challenge is getting nonscience majors involved, reports Uhlenhopp. "It always has been, and perhaps always will be, a problem of bridging the two cultures and getting the humanists, for instance, over into the program." Since Grinnell has no core curriculum, he adds, "we rely very heavily on our advising system to make sure that each student not only gets what he or she elects to take, but gets a broad, well-rounded liberal arts education that hopefully includes, now, increased emphasis on technology." —*D.N.L.*

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Massachusetts Institute of Technology

Addressing Technological Literacy at a Technical Institution

When it comes to preparing well-rounded graduates, faculty members' concerns at an institution such as the Massachusetts Institute of Technology (MIT) present a mirror image of those of their colleagues at liberal arts colleges, maintains Leon Trilling, professor of aeronautics and astronautics. He believes that both types of institutions must address technological literacy—"the sense of how technology affects human attitudes and material culture, and how culture, values, and institutions affect technical choices."

A liberal arts program, says Trilling, may not pay sufficient attention to developing students' awareness of numbers and quantitative models, and ability to define and isolate problems and make decisions in the face of uncertainty. "At MIT we want our students to understand the cultural and social context in which engineering is practiced and decisions are made. They should realize that the quantitative, sequential deductive mode which is drilled into them, is not the only one and that there are qualitative and aesthetic modes which are also important."

During the last two years, MIT faculty members have served as resources for liberal arts instructors in activities funded by the Sloan Foundation's New Liberal Arts Program. In spring 1983 they organized seminars at eight colleges which had received Sloan funding. Faculty from area institutions, as well as the host campuses, attended the one-day seminars, which featured presentations on such topics as the American system of manufacturing and what archeological investigations can reveal about a civilization's culture and technology.

Seven faculty members interested in developing materials which will increase liberal arts students' understanding of science and technology have spent their sabbaticals at MIT during the 1984-85 academic year. Their activities have included library research, sitting in on classes, and "working with those in the MIT community who are concerned with presenting technology in their context," reports Trilling. These contacts have benefited the MIT faculty as well as their liberal arts counterparts, he says. "It has given us all kinds of ideas to pursue and made us more sensitive to how one ought to look at these issues."

Freshman Program Explores Sciences' Cultural Context

The 1984-85 academic year marked the first offering of a freshman program that combines the teaching of mathematics and physics with discussion of their historical, cultural, and social contexts. Taught by faculty members from the Schools of Science and Engineering and the Science, Technology, and Society Program, the Integrated Studies Program (ISP) illustrates how science and humanities course work can be presented together, says Trilling. Students may select ISP as an alternative means for completing the freshman requirements of one year of physics and calculus, one semester of chemistry, two humanities courses, and one or two electives.

ISP students complete their physics and mathematics requirements as one coherent unit, although the content and examinations are identical to those in standard courses to ensure that as sophomores they will have the same level of competence as other students. The first semester physics course examines mechanics, Galileo, Newton, thermodynamics, and the beginning of industry. At the same time, students explore the historical and social context of the scientific revolution in the humanities course, Science and Technology from the Renaissance Through the Enlightenment. Instructors begin by examining the sixteenth century's various world outlooks and cover such issues as the justification and application of science in seventeenth century England, the development of professional armies, the history of engineering education, and the industrial revolution.

The second semester science course deals with electricity and magnetism and does not "connect with humanities in as natural a way" as the earlier course, admits Trilling. Science, Technology and Social Change explores the interrelations of communities with scientific and technical developments. For example, one unit focuses on the social consequences of the advances in telecommunications and considers such questions as "should this industry be considered an extension of the press, with first amendment rights?" and "should it be considered a common carrier subject to the same legislation as railroads?" Other units examine societal and cultural concerns related to mass production, the role of industrial innovation and the marketplace, the transfer of western technology to China and Japan, and nuclear weapons and arms control.

Additional interdisciplinary study is provided in seminars exploring topics ranging from The Influence of Science on Social Values and Changing Perceptions of Work to The Context of Research and Biological Basis of Human Behavior. Trilling's seminar on The Context of Research, for example, considers what makes a scientific problem important, debating whether it is because a problem is relevant, is being pursued by leading scientists, easily secures funding, has obvious applications, and/or will shed light on important concerns. Using accounts of plagues from the Peloponnesian War to the recent swine flu vaccine episode, Trilling next reviews the effect of scientific knowledge on human behavior. These discussions illustrate that "even if you think you know a great deal you can make serious misjudgments," says Trilling.

The ISP attracted 15 students during its first year, a figure expected to double next year based on experiences with similar programs. Although it was more difficult than instructors had expected to coordinate the science materials with their historical contexts, Trilling believes ISP successfully demonstrated that "you can learn a great deal about societies by looking at how they deal with scientific ideas and new technical devices."

—*P.A.B.*

For more information, contact Leon Trilling, Professor of Aeronautics and Astronautics, Massachusetts Institute of Technology, Cambridge, MA 02139. 617/253-7481.

Middlebury College

Modifying Courses for Nonscience Majors

Even as Middlebury College was seeing as many as 60 percent of all freshmen enrolled in calculus courses and noting that the most popular offering on campus was an introductory physics class, the Sloan Foundation funded a proposal designed to introduce students to the wide application of mathematics and technology in social sciences, humanities, and the foreign languages. With the help of a colleague appointed as Resource Professor, faculty members are working "to ensure that as many of our graduates as possible have an acquaintance with formal reasoning, quantitative approaches to problem solving, and an appreciation for the importance of technology in our society," says Robert W. Gleason, dean of the faculty.

"We had already taken steps that pointed us in the same direction as the Sloan New Liberal Arts Program, including the

development of courses in mathematics and sciences for nonmath, nonscience majors," says Michael Olinick, professor of mathematics. "Our students are going to fill leadership positions 20 years from now, and all indications show that a significant number of public issues will involve a substantial amount of scientific or technical data. Our leaders will need the confidence to make intelligent decisions about those public issues."

Middlebury's program is designed to "stimulate our colleagues in all departments to modify existing courses in order to introduce components of formal reasoning, logic, applied mathematics, and technology," says Gleason.

Courses that could be modified, speculates Gleason, include an art course in which students are introduced to the technological aspects of art restoration, and a political science course that includes mathematical issues involved in redividing congressional districts. Olinick sees two principal ways in which foreign language courses can be modified. "There are a number of linguistics courses that contain a natural mathematical component," he says, "and in foreign language literature courses we might talk about gamed theoretical models for the study of conflict resolution." A substantial amount of the Sloan funds will support faculty members by relieving or reducing their teaching loads for a semester while they develop these courses with the Resource Professor.

Resource Professor Aids Course Development

Olinick was chosen as Middlebury's first Resource Professor because of his "long-standing interest in the application of mathematics to the social sciences," says Gleason. "During the deliberations of the planning committee's work, he developed a number of modules that could be introduced into social sciences and humanities courses. He was simply a natural choice."

In addition to helping faculty members modify courses, Olinick, as Resource Professor, will teach two new courses for nonmathematics, nonscience majors. Elementary Computer Simulation will use simulations in gambling, sports, and population dynamics that will allow each student to develop, test, and validate a simulation project. Cryptology: The Mathematics and Technology of Making and Breaking Secret Codes will discuss historical and technical aspects of enciphering and deciphering coded messages.

A portion of the $150,000 Sloan grant has funded faculty development courses during Middlebury's Winter Term that are designed to build the instructors' confidence in utilizing quantitative and technical components in their courses. In winter 1984, approximately 20 faculty members were given release time to attend an introductory computing course. The most recent Winter Term course dealt with the teaching of writing across the curriculum. Olinick will teach a course on game theory during next year's Winter Term. According to Gleason, faculty reaction to the courses has been enthusiastic. "The best thing about those courses is that faculty from disparate and different disciplines have come together, studied together, and found they had a lot in common and much to gain from working with one another," he says.

The Sloan grant covers a three-year period beginning in fall 1985. Olinick will serve as Resource Professor during the 1985-86 and 1986-87 academic years. Another faculty member has been chosen as the second Resource Professor, whose first year will overlap with Olinick's second year and who will then serve the third year of the grant, 1987-88.

Gleason and Olinick hope that the Resource Professor concept will be continued after the grant has expired. "The notion of the Resource Professor need not necessarily be limited to issues touting the new liberal arts," Olinick says. "We might decide that the curriculum would like to have a Resource Professor in economics or composition." Adds Gleason, "We see the Resource Professorship as an extremely effective vehicle for curricular revision." —*S.H.*

For more information, contact Robert W. Gleason, Dean of the Faculty, Middlebury College, Middlebury, VT 05753. 802/388-3711.

Rhodes College

Promoting Computing Competency

Since acquiring its first large computer system in 1977, Rhodes College has striven to keep pace with technological development, making computers available for the entire campus community. "Our efforts to raise technological literacy have centered upon stimulating increased computer usage among faculty, students, and administrators," says Robert Llewellyn, associate dean of the college, who notes that Rhodes has made "a major financial commitment to upgrading computer facilities."

In addition to a computer center and more than 100 terminals located across campus, each office and dormitory room is connected to a mainframe computer, giving every person potential access to a terminal. Faculty members may also purchase personal computers at a discount through the college's five-year loan provisions, and administrators are providing office terminals to all interested instructors. Faculty interest in obtaining computers for either home or office is high, says Llewellyn, with approximately 60 percent of the faculty receiving computer aid from the college in one form or another.

"Our philosophy is that every academic department should use the computer in a way appropriate to its discipline," says Llewellyn, maintaining that because administrators and faculty members want students to have a knowledge of computing relative to their majors, there is no universal computer literacy requirement. Yet, Llewellyn is confident that 80 to 90 percent of all students will have had some computing experience by the time they graduate, and this assumption is strengthened by the fact that the college provides each student with a computer account regardless of his or her major.

Computers Used in Most Disciplines

Llewellyn asserts that computers have become so pervasive on campus that the majority of students, like it or not, will be expected to use them at some point during their academic careers. While students in the sciences would, of necessity, encounter the computer in their courses, those in the humanities and social sciences also have the opportunity to apply the computer to their studies—English majors focusing on word processing and textual analysis programs, and economics and psychology students using the computer in their required statistics courses. In fact, Llewellyn notes, concern for students' computer literacy has become such a priority that the political science department has instituted a series of three courses designed to introduce novices to computer applications. Open to all majors, these courses allow students to progress gradually from simple text editing to statistical analysis of policy issues. A similar sequence exists in the mathematics department, exposing students first to Basic, then Pascal, and finally to more specialized computer languages such as FORTRAN.

Faculty interest, says Llewellyn, has been the driving force behind these computer literacy efforts, and instructors are

"working hard to keep up with the computer revolution." Informal faculty workshops and seminars on such topics as Basic, word processing, and statistical software packages, have attracted faculty members from many disciplines, and the college also provides faculty development grants to professors wishing to attend off-campus programs to refine their computer expertise. Presently, faculty members are working on such projects as using the computer to explore the geometric structure of molecules and create population models.

With the college's commitment to strengthening computer literacy across the curriculum, says Llewellyn, "any faculty member who comes to the dean's office requesting assistance in developing a discipline-related computer competency will not be turned away." —*N.M.L.*

For more information, contact Robert Llewellyn, Associate Dean of the College, Rhodes College, 2000 North Parkway, Memphis, TN 38112. 901/726-3795.

Smith College

Viewing Technology as Part of the Liberal Arts

Categorizing Smith College as an institution with a strong liberal arts tradition, Associate Dean of the Faculty Elizabeth S. Ivey maintains that it is this tradition which has prompted administrators to take a broad-based approach to technological literacy on campus. Faculty members do not single out the technological aspects of their disciplines, she says; rather, they integrate them into the curriculum as a whole.

With the receipt of a Sloan New Liberal Arts Program grant in 1982, administrators developed workshops to facilitate faculty members' use of computers in their research and courses. The workshops, which attracted more than 100 faculty members, were designed for individuals with computing experience as well as for novices. Held in spring 1983, the Use of Computers in Teaching workshop brought together faculty familiar with computers to share their insights and concerns. Topics covered included computer tutorials, simulations, course management, and computer applications (logic, statistics, etc.).

Computers and the Liberal Arts, also offered in spring 1983, illustrated the relevance of the new technology to many disciplines, while Decision Making and Guided Design, held in 1983 and again in 1984, presented the reasoning process used in computing as common to decision making in every discipline. The last workshop, offered in spring 1984, combined lectures with hands-on sessions, exploring such subjects as text processing, computer graphics, and databases. Ivey notes that the workshops have led to faculty-initiated computer user groups, whose members meet often to discuss programming and computer applications. Administrators are now encouraging faculty to develop new courses for the 1985-86 academic year, offering release time and financial support for their efforts.

Currently offered courses reflect faculty interest in computing, says Ivey, who notes that computer applications exist in one form or another in more than 300 courses, including various art offerings, music composition classes, and language labs. In addition, there are interdisciplinary courses that specifically examine the societal impact of technology from a variety of viewpoints. Peace and War in the Nuclear Age studies the conditions of peace and the consequences of war from the perspectives of the natural and social sciences. Art and Technology in the Industrial Era explores the cultural and social aspects of the history of technology; and Science, Technology, and Public Policy focuses on such issues as the ramifications of recombinant DNA research and the problems to toxic waste management.

Computer Science Minors

Because of high student interest in computing, administrators have developed computer science minors to complement the major, says Charles Staelin, associate professor of economics. He maintains that creation of the minors was also related to Smith's commitment to liberal education, noting that there was "a college-wide concern that students were restricting themselves by double-majoring—that they should move out of their major subjects to broaden their education." The minors—Simulation and Modeling; Mathematical Foundations of Computer Science; and System Analysis, Computer Science and Language—were designed to correspond to the interests of students majoring in the social sciences, natural sciences, and humanities, allowing them to relate the study of computer science to their different majors. —*N.M.L.*

For more information, contact Elizabeth S. Ivey, Associate Dean of the Faculty, or Charles Staelin, Associate Professor of Economics, Smith College, Northampton, MA 01063. 413/584-2700, ext. 3010, or ext. 3621.

State University of New York at Stony Brook

Technological Literacy for Nonengineering Majors

Liberal arts students at the State University of New York (SUNY) at Stony Brook can take courses in engineering and technology especially designed for the nonengineering major. While most of the courses were developed in the mid-1970s, the technology and society program was prepared in 1983 in response to the Sloan Foundation's New Liberal Arts Program. Offered through the Department of Technology and Society in the College of Engineering and Applied Sciences, these nine courses are divided into general and technically-specialized categories. All courses are taught by engineering faculty.

The philosophy of the Department of Technology and Society, which offers a minor but no major, is that students entering a technological world must understand it, according to Marian Visich, Jr., associate dean of the engineering college. "When people are involved in making decisions on technological matters, they need to look at alternatives and limitations to that technology in addition to its impact and long-range economic effects," he says. "This understanding makes students better, well-rounded citizens."

Three general courses provide an overview of problem areas that students face and are open to all, according to Visich. The most popular, People, Technology and Society, discusses case studies in technological problems from automobile safety to the energy crisis and water supply problems. Specific case studies change each semester based on student interest and national and international developments in technology. Current topics of discussion include acid rain and the safety of nuclear power plants. Engineering Methods of Problem-Solving introduces students to the techniques of modeling and decision-making.

Computers and Society covers a wide range of topics on the applications of computers in the modern world.

The six technically-specialized courses have prerequisites, generally one year of college mathematics or science. Says Visich, "Each course is devoted to one specific topic, as opposed to the overview aspect of the general courses." Audio devices, computer-generated speech, and biological effects of electromagnetic signals are three specific topics discussed in Communication, which helps students understand modern electronic communications technology.

Selected topics in electronic communications are included in the Information Age Seminar, while Technology in War and Peace discusses strategic considerations. Other technically specialized courses include Transportation Planning and Engineering Economic Systems. Visich teaches the newest offering, The Exploration of Space, which discusses scientific and engineering capabilities and principles.

While there is some development of new courses for nonengineering majors, such as one on energy policy and alternative forms of energy, Visich says that "unless we can bring on additional faculty, it is somewhat difficult to change courses every year. Besides, so many of the courses are quite popular with our students."

Students Recognize Value of Technological Understanding

According to Visich, approximately 1,000 students take courses in the Department of Technology and society; 80 percent are liberal arts students, with 20 percent pursuing engineering or other majors. Visich cites faculty excellence and their willingness to discuss student questions outside of class as two reasons that the courses have become so popular with Stony Brook liberal arts students. But he mentions another, more practical, reason as well. "Because of the problem of employment for liberal art students," sayd Visich, "they find it to their advantage to have a minor in technology and society on their transcript. It opens a lot of doors when they go out looking for jobs." About 35 students are graduating in spring 1985 with a minor, for which they must take six courses on the impact of technology on society. A few engineering students take the minor; liberal arts majors have represented economics, history, and sociology.

Visich is pleased with the liberal arts students' reception of the technology and society courses. "We are especially happy from the point of view that these are elective courses," he says. "The students are interested in the problems facing them today and are looking for ways to get involved in the solution. Mostly, they want to understand, which is key to a good student's background."

The Stony Brook campus is also home of the Sloan Foundation-funded Stony Brook Center, a resource center designed to interact with liberal arts colleges and assist with curriculum development and other activities related to the interests of the New Liberal Arts Program. The center is intended as an information clearinghouse for all colleges and universities and will begin to extend the influence of the Sloan program beyond the funded projects through newsletters and other publications. In summer 1985 the center will coordinate four faculty workshops, principally for representatives of institutions active in the Sloan program, on such topics as medical technology, engineering principles, technology for nonengineering students, quantitative sociology, and arms control and the technology of nuclear weapons. —*S.F.*

For more information, contact Marian Visich, Jr., Associate Dean, College of Engineering and Applied Sciences, State University of New York at Stony Brook, Stony Brook, NY 11794. 516/246-6750.

Union College

Quantitative Issues and Contemporary Concerns

Since 1977, Union College undergraduates have taken two courses in symbolic and quantitative reasoning and one course in technology and its social applications as part of the required Liberal Learning Program. The former courses help students learn to use quantitative reasoning and numerical data, according to J. Richard Shanebrook, professor of mechanical engineering and director of the college's Sloan Program. Technology and its social applications courses examine technology and its effect on our lives and the future. With a grant from the Sloan Foundation, faculty members are developing and revising courses that satisfy the two requirements, and integrating quantitative and technological materials into other offerings.

During spring 1985, instructors from the departments of economics, sociology, biology, and mechanical engineering are offering a freshman course in quantitative analysis for the second time. Decision Making in Contemporary Problems is a parallel to the required Freshman Preceptorial, says Dwight Phaup, an economics professor who teaches one section of the course. While the Freshman Preceptorial develops critical thinking skills in written analyses of readings representative of a variety of liberal arts disciplines, the decision making course addresses the same skills in its attention to how quantitative tools can be used to understand contemporary problems drawn from various fields, explains Phaup.

The "quantitative preceptorial," as it is informally called, helps students become "better consumers of the quantitative information that is used in public policy debate and understand that evidence is not always presented in an unbiased, forthright way," says Phaup. The instructors introduce quantitative tools and conceptual approaches in their discussion of such topics as cost benefit analysis, arms negotiation, and poverty in the United States. In one exercise students use cost benefit techniques to determine whether or not it was an appropriate decision for them to attend college. For the final project, student teams debate a public policy question, backing up their positions with reference to specific data and the tools for using it. The course counts toward the symbolic and quantitative requirement and may become a required freshman course.

Humanities Courses Offer Computer Experience

The Sloan Foundation also helps fund the Computerized Humanities Undergraduate Curriculum Project (CHUC), a group of nine humanities instructors who are integrating computer simulations and word processing into their courses. For two summers, the computer science department chairperson introduced the humanities faculty to programming and word processing in workshops that resulted in the new project. The CHUC instructors meet regularly to discuss how they are using computers in their courses and to critique each other's computer-assisted assignments. With a Digital Equipment Corporation hardware grant, CHUC also runs a microcomputer classroom with 15 work stations for simulations and word processing. Twelve teaching assistants, who are primarily humanities students, run the classroom and help students with their CHUC assignments. CHUC courses include Introduction to Philosophy, which uses word processing to help develop students' writing and reasoning skills, and History of the Crusades, which will use computer assisted instruction to help students visualize the changing map of Europe through the Crusades.

Other new courses include Technological Values and Nuclear Technology in War and Peace: A Study of Issues and Choices, which satisfy the technology and its social implications requirement. Technological Values uses computer simulations and word processing in its study of the relationships between computers and people. The latter course presents a historical overview of nuclear technology from the scientific discoveries of Roentgen, Becquerel, and Curie to the Three Mile Island accident and focuses on the technology of nuclear power plants and modern nuclear weapons and delivery systems. The course demonstrates that "learning about technology is not impossible for the layperson," says Shanebrook, "and making choices about technology requires factual information."

This approach characterizess all of Union's efforts to increase students' understanding of technological and quantitative concerns, according to Shanebrook. "Students should be able to combine the ability to reason and express themselves orally and in writing with a knowledge of technology in such a way that they are able to make decisions regarding technological issues."

—*P.A.B.*

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Wesleyan University

Integrating Computers
Into the Liberal Arts Curriculum

For Wesleyan University, a crucial technological issue is the use of computers in liberal arts education. Thus, when the university received a Sloan Foundation grant, Vice President for Academic Affairs Nathanael Greene invited ten faculty members from various parts of the university to serve on a computing task force and plan for the integration of computers into the curriculum of this liberal arts institution. Task force members came from such diverse areas of the university as the art, romance languages, and mathematics departments, the library, the language laboratory, and the administration; some members were familiar with computers, and others were not. Chaired by David Todd, director of University Computing, the task force met throughout the 1983-84 academic year.

One of the group's main goals, according to its final report, was "to make members of the Wesleyan community more aware of the impact of computers upon society and the educational process and to alert them to future developments" in the use of computers. For that reason, the task force sponsored a lecture series to generate interest among faculty, students, and administrators. Four lectures were presented by speakers from industry and other universities. The first two, on very general topics—The Evolution of Computers and Are Computers Really Good for Kids?—attracted a large audience. More specialized lectures on computer animation and the use of computers in music drew smaller numbers. Speakers were invited to come early and meet in small groups with interested faculty, administrators, and students.

The task force also offered departmental seminars on computing. Several departments invited experts from other institutions to speak on such subjects as computers and the classics, computers and the human spirit, and computer-assisted learning in the languages. These presentations allowed faculty members and students to explore more specialized computer issues within the context of their own disciplines.

As these topics indicate, the task force was concerned not with learning about the computer itself, but with learning to use the computer as a *tool* in other disciplines. Rather than calling for more computer science courses, the task force looked for ways to "integrate the computer as a tool into the entire liberal arts environment," said Todd. Therefore, a major thrust of the group was to stimulate faculty interest in the use of computers for research and instruction. Up to a certain point, students will learn about computers on their own, says Todd, but if the computer is going to be integrated into the total curriculum the faculty will have to bring that about. To do this, they have to be comfortable with the computer, especially for their own research.

On-going Computer Activities

In its final report in May 1984, the task force made a number of recommendations. Chief among them was the establishment of an academic computer advisory committee to carry on the planning activities of the task force. This committee, according to Todd, is now in operation. Many of its activities are aimed at increasing faculty involvement with computers. For example, the task force recommended that the committee plan an instructional resource center, which would help faculty use computer-aided instruction. Such a center would encourage faculty members to share their experience and problems and to explore different uses for computers.

The task force further recommended that the committee evaluate the success of a project initiated last year under which personal computers were allocated to 25 faculty members in the social sciences. This project was meant to encourage faculty to use computers more widely for research and especially for instruction. An evaluation would determine the effectiveness of this project.

The committee is also investigating the possibility of a large-scale student purchase plan to help interested students buy their own personal computers. Planning for this is now well under way, although several important questions remain to be answered. For instance, the university must still decide which computer to buy and how to provide an equitable arrangement for students of different income levels. The university is not requiring students to own computers but is trying to provide access to computers for all students.

All three of these efforts—the instructional resource center for faculty, the allocation of personal computers to faculty, and the student purchase plan—should help to develop a feeling of community in the use of computers, according to Todd. Students and faculty will have access to personal computers which can communicate with the university's main frame computer and with each other. They will also have opportunities to work together on projects using the computer as a tool to further their research, writing, and classroom experiences. —*M.R.*

For more information, contact David Todd, Director of University Computing, Wesleyan University, Middletown, CT 06457. 203/347-2511.

Billington, David P. *The Tower and the Bridge: The New Art of Structural Engineering*. New York: Basic Books, Inc., Publishers, 1983.

Billington illustrates "how (the Eiffel) tower and (the Brooklyn) bridge are only two of the numberless works of recent engineering that constitute a new art form, structural art, which is parallel to and fully independent of architecture." He begins with the late eighteenth century iron bridges, noting their influence on the modern engineering profession, and traces the evolution of principles of form in structural engineering. The book's first half focuses on the great works of iron built into the late nineteenth century, while the second half explores the use of steel and concrete in this century. Acknowledging that technology is frequently equated only with machines, Billington calls structures—artifacts such as those which create water supply, permit transportation, and provide shelter—the more static side of technology and examines their balance of conscious aesthetic choice, nature's laws, and material properties.

Chen, David and Novik, Ruth. "Scientific and Technological Education in an Information Society." *Science Education* 68 (July 1984).

Because of the highly sophisticated developments in technology during the last 20 years, the authors believe that policymakers in education, particularly in science education, must constantly revise and update knowledge and information so that "old images of reality are replaced by new ones." As science and technology have helped determine the character of society, the curriculum must not be detached from society's every day experiences, say Chen and Novik. They argue that science education should be "extended beyond the scope of scientific discipline to its applied aspects."

Cochrane, Charles H. *Modern Industrial Progress*. Philadelphia: J.B. Lippincott Co., 1904.

Cochrane maintains that ingenuity, coupled with the necessity that resulted from the lack of imported machines, has produced in the United States "a race of mechanicians that have revolutionized construction in numerous industries." He observes that few people understand aspects of industry outside their immediate experience and sets out to overcome this ignorance by describing prominent industries and their machines and processes. Commenting on the background and impact of these industries, Cochrane offers details on the workings of various machines, supplemented by charts, illustrations, diagrams, and information on production costs and output. Topics covered include the iron and steel industry, automobile manufacture, electricity, textile manufacture, canals, tunnels, and sugar manufacture. For example, a chapter on newspapers and periodicals includes a brief summary of the changing focus of American periodicals, how news is gathered, and the effect of advertising on the cost of purchasing a newspaper, in addition to describing the processes and capabilities of various presses and linotype machines.

Council for the Understanding of Technology in Human Affairs (CUTHA), Massachusetts Institute of Technology, Room E40-481, Cambridge, MA 02139. 617/253-8074. Leon Trilling, Council Board Chairman.

Established in 1979, CUTHA consists of 21 educators, industrial leaders, and public officials, elected for three-year terms, who are committed to promoting a broader understanding of technology and its impact. Recognizing that "a general understanding of technology... is consistent with liberal education's objective of making the world comprehensible," CUTHA assists with the development of multifaceted approaches to technology education, emphasizing the integration of engineering content into the liberal arts curriculum. Activities include consultations, publications, workshops, and seminars. Of special interest is *The Weaver*, CUTHA's newsletter "of information and perspectives on technological literacy," features include articles on various aspects of technology (for example, the winter 1985 issue focused on bioengineering), an annotated "readings that help" section, and announcements of activities and publications of related organizations. Complimentary subscriptions are available from Barrett Hazeltine, Professor of Engineering, Division of Engineering, Brown University Box D, Providence, RI 02912.

Cutcliffe, Stephen H., Mistichelli, Judith A., Roysdon, Christine M. *Technology and Values in American Civilization: A Guide to Information Sources*, Volume 9 in the American Studies Information Guide Series. Detroit: Gale Research Company, 1980.

This resource guide provides more than 700 pages of annotated entries on bibliographies, books, and articles related to the interaction between man and technology. It focuses both on materials documenting how American values have molded attitudes toward technology and on those examining technology's affect on the formation of values. Thematic groupings include historical background, the innovative process, industrialization, urbanization, labor, the economics of technology, and case studies of companies, industries, cities, and towns. It also lists journals which regularly publish articles relating to technology and values.

The Forum for Liberal Education.

This issue marks the second time *Forum* has examined technological concerns. The December 1980 issue on Technological Literacy and the Liberal Arts described such efforts as Lehigh University's Humanities Perspectives on Technology, the University of California, Los Angeles Patterns in Problem Solving course, and the University of Wisconsin-Madison's Sociological Systems Design Program. In the lead essay Guest Editor Edward A. Friedman presented an overview of technological literacy and the need for responding to the educational challenges of the technological age. *Forum* issues which have covered related themes include Computer-Based Learning (May 1981), which began with three essays exploring the role of computers in liberal education, in the humanities and social sciences, and in the natural sciences; Science Literacy for All Students (October 1982), which stressed the necessity for both science and nonscience majors to understand science principles, capabilities, and limitations; and Computer Literacy...would Plato understand? (May 1983), which illustrated the different ways campuses are reacting to the computer revolution. Individual copies of each issue are available for $3.25 each (prepaid) from *Forum*, AAC, 1818 R Street, N.W., Washington, D.C. 20009.

Haberman, Martin, ed. *Journal of Teacher Education* 34 (September-October 1983).

This issue presents seven articles related to the theme of "high technology and computers in higher education." In an essay titled "Dimensions of Technology Literacy in Teacher Education," George Uhlig cautions that computers are only the tip of the technology iceberg. He identifies ten issues which have import for teacher education, including the observations that technological literacy, unlike some other kinds of literacy, is a lifelong process; telecommunications will make the home once again the center for learning; and the issue of have and have nots, in terms of which school districts have the necessary equipment, cannot be underestimated. In her article on computer literacy, Cheryl A. Anderson calls for retraining of teacher education faculty and encouraging them to use computer based instruction in their own courses so that teacher trainees can experience computers from a learner's perspective, and continuing education for inservice teachers. "Microcomputers and Macrocautions" by Chris Stevens warns that computers cannot substitute for direct encounters with others and that machine calculations cannot substitute for human judgment. Other articles examine a computer-managed teacher education curriculum and the impact of educational computing on teacher education.

Hamm, Manfred and Steinberg, Rolf. *Dead Tech: A Guide to the Archaeology of Tomorrow*. San Francisco: Sierra Club Books, 1981.

This volume presents a photo-essay by Hamm, with accompanying text by Steinberg, on the grotesque beauty of already decaying artifacts of recent technology. The authors illustrate how new technologies are spreading faster than society can discard the obsolete. The black-and-white photographs include shots of steam engine stacks, rotting harbor areas, automobile and aircraft graveyards, and the nuclear power plant at Three Mile Island.

Hounshell, David A. *From the American System to Mass Production, 1800-1932: The Development of Manufacturing Technology in the United States*. Baltimore, Maryland: Johns Hopkins University Press, 1984.

Hounshell focuses on the relationship between industry and society, tracing the American system of mass production from the federal armories at Harper's Ferry to Henry Ford's automobile assembly lines. He examines the manufacture by mass techniques of sewing machines, wood-working industries, agricultural equipment, typewriters, and bicycles, reporting on the prompt transference of innovations from one industry to another, and the new problem of overproduction. A final chapter focuses on the ethos of mass production and includes such artistic reponses to the new technology as Huxley's *Brave New World*, the Charlie Chaplin film *Modern Times*, and Diego Rivera's murals of the Ford River Rouge complex. One appendix outlines the chronology of the expression "the American system of manufactures," while another presents an artifactual analysis of Singer sewing machines made between 1865 and 1885, which includes close-up photographs of various parts. Hounshell also lists related manuscripts, public documents, and books, including several contemporary to the period covered.

Hudson, Kenneth. *World Industrial Archaeology*. Cambridge, England: Cambridge University Press, 1979.

Hudson discusses industrial archaeology and the techniques appropriate to its study. He offers five reasons for studying industrial archaeology: to learn about the conditions of work at particular periods in history, including the attitudes of the employers and workers; to obtain information on employer and worker income, satisfaction, health, standard of living, etc.; to gather information about work procedures and how machinery and equipment were used; to comprehend the scale of the industrial operation; and to record or recreate the physical environment. Hudson looks at plants, mines, wheelhouses, factories, mills, lighthouses, and other locales worldwide and discusses the "contribution that industrial archaeology can make to the study of history." Specific sites include a Gold Rush ghost town in California, a windmill-assisted salt mine in France, a shoemaking complex in England, and an oil refinery in Sweden.

Kasson, John F. *Civilizing the Machine: Technology and Republican Values in America, 1776-1900*. New York: Grossman Publishers, 1976.

Kasson explores the meaning of technology for a republican civilization, noting the difficulty of achieving a technological society consonant with republican ideals. Exploring how American independence and industrialization shaped our civilization, he provides an intellectual and social basis for industrialization and the growth of machines and technology, focusing his discussion on five themes: the introduction of domestic manufactures in America; the model factory town of Lowell, Massachusetts; Ralph Waldo Emerson's thoughts on technology, the asethetic response to machinery; and the utopian and dystopian novels of the late nineteenth century. In the latter section, for example, he describes the content and perspectives of various utopian novels, including how the industrial army in Edward Bellamy's *Looking Backward, 2000-1887* is a picture of the American technological republic in the future while Mark Twain's *A Connecticut Yankee in King Arthur's Court* presents a technological republic from the distant past.

Kiernan, Thomas. *The Road to Colossus: A Celebration of American Ingenuity*. New York: William Morrow and Company, Inc., 1985.

In 200 years the United States has become the richest and most variegated country in the history of the world in terms of its economic, social, industrial, and technical prowess, according to Kiernan. He chronicles American inventiveness, beginning with its roots in Bacon's efforts to direct science and technology toward more practical outcomes, and details the development of domestic manufacturing facilities, steam power, and metallurgical expertise, and the marriage between science and business, as exemplified by the work of Thomas Edison and Alexander Graham Bell. Kiernan also examines how government structure, international relations, and the economic system have affected this process. A secondary theme is the negative, unintended consequences of technology; Kiernan asks whether America is dying as "every mighty nation or society" eventually does. Recognizing the current problems reflected in industry's foreign competition, he calls for a rebuilding of America's engineering spirit and scientific and engineering aptitude.

Koerner, James D. *The New Liberal Arts Program: A Status Report*. New York: The Alfred P. Sloan Foundation, 1984.

Providing an overview of the Sloan Foundation's New Liberal Arts Program, Koerner describes it as "an attempt to close escape routes" often taken by undergraduates wishing to minimize their involvement with mathematics and sci-

ence. Developed to ease students' mathematics and science anxiety, the program stresses the infusion of quantitative and technical skills in liberal arts disciplines, thus making students more comfortable with and knowledgeable in technology fields. The program was proposed in 1981, and by 1982, the foundation had invited the first 30 independent liberal arts colleges to compete for grants; ten colleges received $250,000 grants, while the rest received $25,000 grants. These institutions, reports Koerner, have taken various approaches to incorporating technical skills into their liberal arts curricula, some focusing on courses, others concentrating on faculty development. The most common activity focuses on the computer. He notes future plans to disseminate information on the program through a variety of teaching materials and institutional models and to help minority institutions satisfy the program's aims. (Through the resource center at the State University of New York at Stony Brook, the foundation is extending the program's reach beyond the funded institutions to all colleges and universities; see the "additional program" article on SUNY-Stony Brook.)

Koerner, James D., ed. *The New Liberal Arts: An Exchange of Views*. New York: Alfred P. Sloan Foundation, 1981.

In the opening essay, Stephen White offers a brief summary of the evolution of liberal education, noting that its purpose has always been to provide an acquaintance and mastery of various modes of thought. Advocating the inclusion of quantitative skills and an understanding of technology in the liberal arts curriculum, he write, "To believe, in this era, that a man possesses a liberal education who is ignorant of analytic... and technological skills is to make a mockery of the central concept of liberal education and to ignore the nature of the world in which the graduate will live, and to which he hopes to contribute in one way or another." The remainder of the monograph is devoted to the reactions of ten educators to White's piece, which also recommends establishing a program to fund the kinds of studies he advocates. Historian Frederick Rudolph, for example, agrees that the purpose of a liberal education must be to make the world comprehensible and suggests attention to analytic skills and technological literacy in all degree programs. Elting Morison, professor emeritus at Massachusetts Institute of Technology, also urges that all students "become engaged in the unfinished business in the outlying society—the problems not yet solved, the questions not yet answered, the opportunities not yet followed through." (The preceding resource entry describes the Sloan program which had its roots in these discussions.)

Lawless, Edward W. *Technology and Social Shock*. New Brunswick, N.J.: Rutgers University Press, 1977.

Lawless presents 45 case studies that illustrate the diverse effects of technology on institutions and individuals. "Social shock" is the public alarm over problems created by new technology; Lawless' examples include DDT, artificial insemination, the mercury in tuna scare, and enzyme detergents. Each case study includes background material, key events, and a disposition. The chapter on thalidomide, for example, covers the birth defects caused by the use of this tranquilizer in the late 1950s and reports how the aftermath of "social shock" resulted in increased study of prenatal deformities, stricter laboratory testing procedures for new drugs, and legislation requiring that the safety and effectiveness of a drug must be shown before it can be marketed.

Lindauer, George and Hagerty, Joseph. "Technology and Society—An Upper Level Course." *Engineering Education* 74 (April 1984): 666-668.

The authors describe an upper level course at the University of Louisville which all five-year engineering students are required to complete. A course goal is an investigation of the quality of life in modern technological society, in order to understand the threats to that quality, as well as the promise of enhancing it, arising from technology and technological change. The course's eight modules cover such areas as the scope and effect of technology, historical developments in technology, the interrelationship of technological and societal values, and the ethical problems facing engineers. Students prepare for presentations and debates on the various topics and examine case studies on such problems as the Pinto gas tank and the dilemma of the whistle blower; class discussions are stimulated by requiring written summaries of readings and problems. Students also submit weekly clippings on related topics from the popular press. The majority of students feel the course is relevant to their future careers, while 80 percent believe it will affect their approaches to future technological problems.

Mathews, Walter, M., ed. *Monster or Messiah? The Computer's Impact on Society*. Jackson, Miss.: University Press of Mississippi, 1980.

Mathews explores such topics as the computer's historical context and values in the computer age. He briefly traces technological developments in history leading to the creation of the computer and shows a parallel between the railway revolution of the nineteenth century and the computer revolution of today. Mathews also addresses the computer's impact on society from the worlds of art, social welfare, education, and communications. A common thread running throughout the book is the need to emphasize humanistic values even while embracing the new technology of computers.

Olinick, Michael. *An Introduction to Mathematical Models in the Social and Life Sciences*. Reading, Mass.: Addison-Wesley, Publishing Company, 1978.

This is a textbook designed to introduce undergraduates to the concepts of mathematical modeling and the contributions mathematics has made in the twentieth century. Olinick discusses how applied mathematics, simulations, and probability theory can help solve problems in political science, economics, hospital planning, and anthropology. Requiring little technical background of students, the text offers exercises and references on topics such as the arms race, ecological problems, epidemics, and social choice and voting procedures. It includes appendices of sets, matrices, and equations and answers to selected exercises.

Post, Robert C., ed. *1876: A Centennial Exhibit*. Washington, D.C.: Smithsonian Institution, 1976.

This book marked the opening of a Smithsonian exhibit celebrating the centennial of the Centennial, as the U.S. International Exhibition came to be informally called. The 1876 exhibit had changed Americans' perception of themselves, and the world's perceptions of Americans; fairgoers were stunned by the American productive genius and material progress. The book captures the mood of the era with its descriptions of the various exhibits, including Machinery Hall's steam and internal combustion engines and the range of

products manufactured in the United States in 1876, such as ceramics, furniture, scientific and surveying instruments, and time-keeping devices. Illustrations are accompanied by essays detailing the history of various artifacts and processes.

Tsurumi, Yoshi. "Too many U.S. managers are technologically illiterate." *High Technology*, April 1984, pp. 14-16.

Tsurumi argues that the most serious problem facing American business is the inability of managers and executives to solve real-world problems and make decisions requiring the weighing of such variables as sales and costs and price and market share. After examining career backgrounds of Japanese and American executives in leading industries, he learned that two-thirds of the Japanese leaders have science or engineering degrees compared to one-third of the Americans. He contends that companies such as IBM, Proctor and Gamble, and Dupont, which have executives with career patterns similar to their Japanese counterparts, "have conceded nothing to their Japanese competitors." The preparation of American managers, writes Tsurumi, "tends to make them aloof from the factory floor and from the human beings who are involved in the day-to-day task of making products," as demonstrated by their emphasis on legal and financial solutions to industry problems rather than technical or human ones. The early experiences of young Japanese executives encourage them to learn from mistakes while Americans must produce immediate results. The irony of this situation, Tsurumi reports, is that the Japanese system is based on an extinct American system that emphasized practical knowledge and hands-on experience.

Note to Readers

This issue of *Forum* concludes volume seven. Topics covered during the 1984-85 academic year included Writing Programs (October 1984), Teacher Education (November/December 1984), Extending Liberal Education to New Audiences (January/February 1985), Promoting Civic Literacy (March 1985), and General Education Evaluations (April 1985). Additional copies of these issues are available for $3.25 each from the *Forum* office. An index to volume seven will be sent in the next month; subscribers will receive their renewal notices at this time.

In lieu of a formal evaluation of this year's volume, the staff is asking readers to send us their reactions to the various issues. We are especially interested in whether or not you find the *Forum* content and topics useful, have contacted any of the contact persons listed at the end of the articles, and/or have used *Forum* in efforts to revise or develop courses and programs. We also welcome your suggestions on what other types of information you would like to see included in *Forum* or themes you would like us to cover next year.

The tentative topics for volume eight are

- Collaborative Learning Activities for Students and Faculty
- Communicating the Value of Humanities
- Cooperative Activities with Business
- Interdisciplinary Studies
- Campus efforts that already address the concerns raised in AAC's *Integrity in the College Curriculum*, the final report of its Project on Redefining the Meaning and Purpose of Baccalaureate Degrees

If you would like your activities considered for inclusion in an upcoming issue, please contact Peggy Ann Brown, *Forum* Editor, AAC, 1818 R Street, N.W., Washington, D.C. 20009. 202/387-3760, ext. 30.

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